North Head

Ecohealth Report 2020

australian wildlife conservancy

Summary

Australian Wildlife Conservancy (AWC) has implemented an Ecological Health Monitoring Program to measure changes in the status and trend of conservation assets, and threats to those assets, across North Head. Metrics from the program are reported in annual Ecohealth Reports and Scorecards. This is the Ecohealth Report for 2020. Values of metrics derived in this report were based on data collected during surveys carried out in 2020. The complete set of metrics and their values are summarised in the accompanying Ecohealth Scorecard.

In implementing the Ecohealth program at North Head in 2020, AWC conducted a total of 1,200 Elliott and cage trap nights, 1,348 camera trap nights, 504 nest box checks, 576 nights of predator surveys, 140 nights of reptile surveys, and three amphibian surveys.

In total, seven native mammal species and five amphibian species were recorded during surveys.

North Head is home to an Endangered population of Long-nosed Bandicoots (OEH 2017). In 2020, there population size was estimated at 183 individuals; the numbers on the headland have gradually increased with each survey since 2010.

AWC has reintroduced three native species of small mammals to North Head. Of these, Bush Rats have become one of the most common native mammal species on the headland. Capture rates remained high in 2020 and Bush Rats continued to be detected at all survey sites. Eastern Pygmy-possums maintained their presence at North Head in 2020, but as for previous years, were detected in low numbers. The Brown Antechinus had low detections (two of 20 survey sites), consistent with previous years. Since reintroduction, this species has not been recorded at more than three survey sites in any year.

In relation to threats, feral predator activity continues to remain low to absent. No cats were detected in 2020, the same result as for the previous year. Some fox activity was detected, triggering a targeted removal program by NPWS.

In October 2020, a prescribed fire lit in the adjacent National Park escaped containment lines and burnt ~23% of the headland (including ~22% of the Sydney Harbour Federation Trust (SHFT)/AWC project area). A number of native animals were adversely affected by this event, with evidence of direct mortality and declining health indicators in surviving individuals. In response, AWC initiated a range of activities aimed at supporting fauna populations and facilitating recolonisation of burnt areas, including provision of supplementary food and water, and deployment of artificial habitat/shelter in the fire scar.

Future monitoring will allow effects of management interventions (e.g., species reintroductions, prescribed burns, vehicle access restrictions) and unplanned events (e.g., wildfire) on ecological health indicators to be investigated, along with other drivers of spatial and temporal change (e.g., weather patterns).

Contents

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Cover photograph: Sunrise over North Head's eastern cliffs. AWC/Holly Nelson

Introduction

Australian Wildlife Conservancy (AWC) owns, manages, or works in partnerships across 30 properties in Australia, covering almost 6.5 million hectares, to implement our mission: *the effective conservation of Australian wildlife and their habitats*. AWC relies on information provided by an integrated program of monitoring and research to measure progress in meeting its mission and to improve conservation management. AWC's Ecohealth Monitoring Program has been designed to measure and report on the status and trends of species, ecological processes and threats on each of these properties (Kanowski et al. 2018). The program focuses on selected 'indicator' species, guilds, processes and threats, using metrics that are derived from data collected through a series of purpose-designed surveys.

The structure of the Ecohealth Program on each AWC property is as follows. Based on the guidance provided by AWC's over-arching program framework, above, Ecohealth Monitoring Plans are developed, describing the conservation values or assets of each property, and threats to these assets; and setting out the monitoring program that will be used to track the status and trend of selected indicators of these conservation assets and threats. Annual survey plans and schedules are developed to implement these over-arching Monitoring Plans. The outcomes of these surveys are presented in annual Ecohealth Reports and summary Ecohealth Scorecards.

This document, the North Head Ecohealth Report 2020, draws on surveys conducted during 2020 to calculate values for metrics that track the status and trend of the Ecohealth indicators at North Head. The companion North Head Ecohealth Scorecard 2020 presents these metrics in a summary format.

North Head Sanctuary

North Head is a site of high ecological value within the Sydney Basin (Figure 1). North Head is within the traditional lands of the Gayamaygal people. It protects the majority of the remaining Eastern Suburbs Banksia Scrub community (listed as Endangered nationally, Critically Endangered in NSW) (Figure 2), and a population of Long-nosed Bandicoots (*Perameles nasuta*) (listed as Endangered in NSW). However, North Head has also suffered biodiversity losses on a scale similar to many other parts of Australia, including the local extinction of a number of species, especially mammals vulnerable to introduced predators.

Since 2009, under contract with the Sydney Harbour Federation Trust (SHFT), AWC has run an integrated set of projects that aim to prevent further loss of biodiversity at North Head, restore animal assemblages and their associated ecological processes, and monitor key conservation assets and threats. AWC is contracted to manage 74 ha of land in the middle of the headland for which SHFT is responsible (30% of total headland area; Figure 2). However, since Ecohealth indicators extend across the headland, surveys associated with the Ecohealth Program are not restricted to this 74 ha area (i.e., surrounding areas managed by NSW NPWS are included, by agreement with NPWS). Including the entire headland area in surveys allows Ecohealth indicators to be monitored and managed holistically.

There are no extant large mammals on North Head. Of the small to medium-sized mammals historically present, five species persist: Water Rat (*Hydromys chrysogaster*), Long-nosed Bandicoot, Short-beaked Echidna (*Tachyglossus aculeatus*), Common Ringtail Possum (*Pseudocheirus peregrinus*) and Common Brushtail Possum (*Trichosurus vulpecula*). Small to medium-sized mammals are particularly susceptible to predation by introduced predators and habitat degradation (Radford et al. 2018) and at least five species (Eastern Pygmy-possum (*Cercartetus nanus*; EPP), Brown Antechinus (*Antechinus stuartii*), Bush Rat (*Rattus fuscipes*), Eastern Quoll (*Dasyurus viverrinus*) and Rufous Bettong (*Aepyprymnus rufescens*)) have become locally extinct from the North Head area since European settlement. Two bird species (Diamond Firetail (*Stagonopleura guttata*) and Eastern Ground Parrot (*Pezoporus wallicus*)), two frogs (Giant Burrowing Frog (*Heleioporus australiacus*) and Wallum Froglet (*Crinia tinnula*)), and one reptile (Broad-headed Snake (*Hoplocephalus bungaroides*)) are also locally extinct.

Between 2014 and 2019, AWC reintroduced three locally extinct small mammal species to North Head: Eastern Pygmy-possum, Brown Antechinus and Bush Rat.

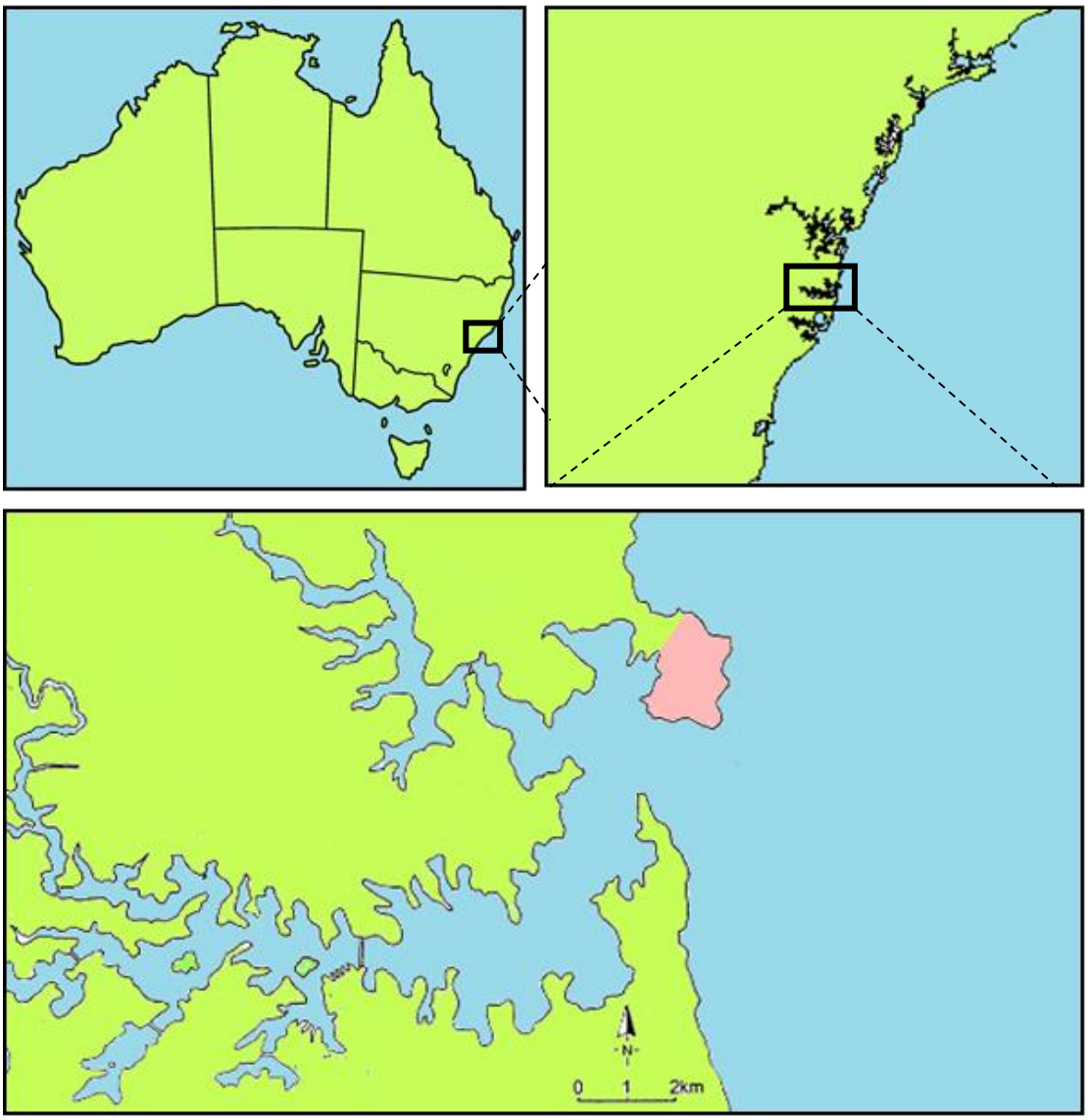

Figure 1. Location of North Head, NSW Australia

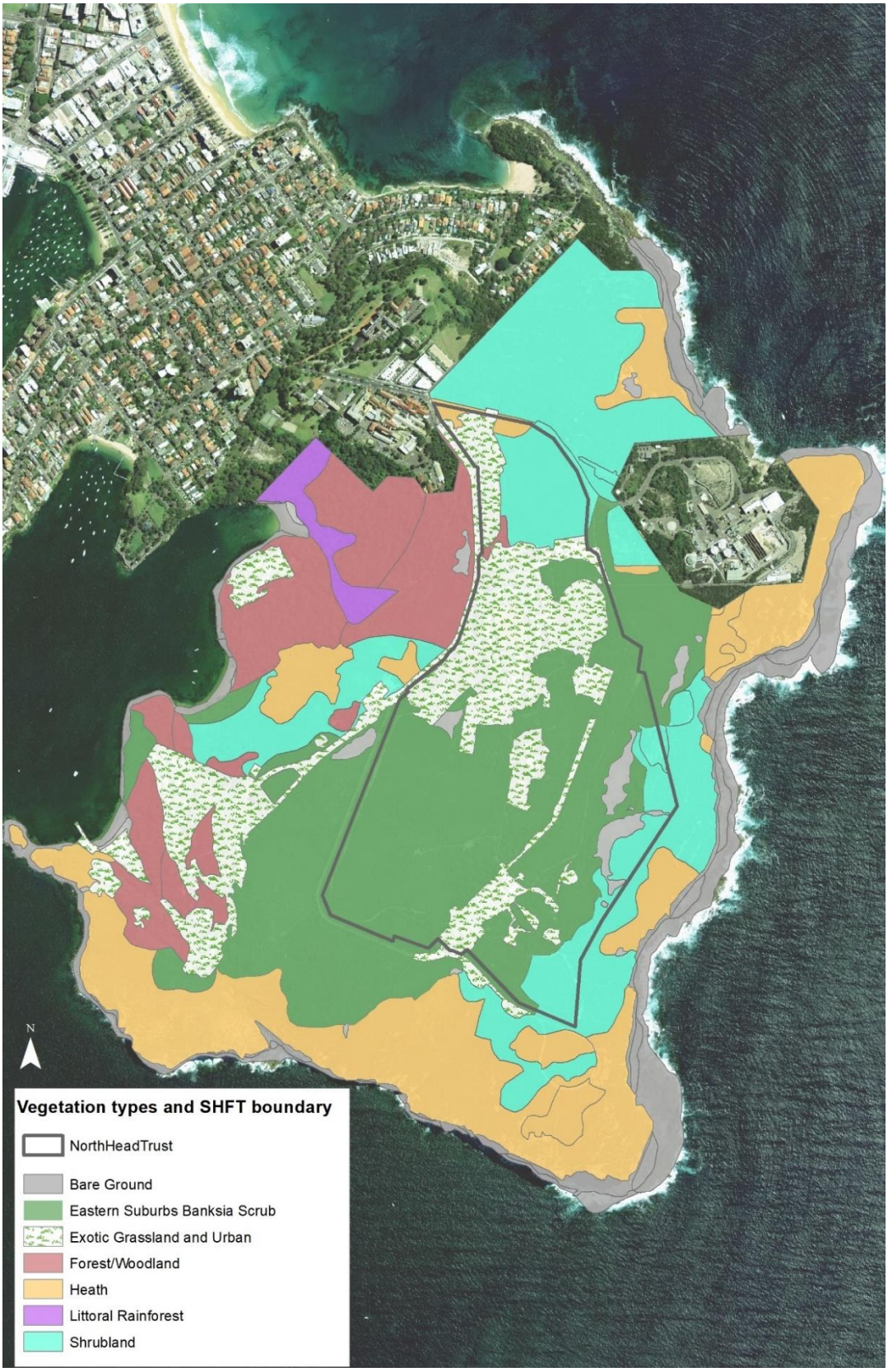

Figure 2. Vegetation types on North Head. Note the map extends across all tenures on the headland. AWC's contract with the Sydney Harbour Federation Trust concerns 74 ha of land managed by the Harbour Trust in the middle of the headland (area encompassed by dark grey line).

Climate and weather summary

The climate in the Sydney region typically consists of warm summers and mild, cooler winters. Annual average rainfall is ~1,230 mm, distributed across the year, but with summer/ autumn generally being wetter than spring (Figure 3). Rainfall in 2020 was 1,554 mm, well above average, primarily due to large totals received in February. Mean maximum temperatures range between 26°C in summer and 17 °C in winter. 2020 was hotter than average, with a mean temperature of 29°C in January, and a mean low of 18°C in July.

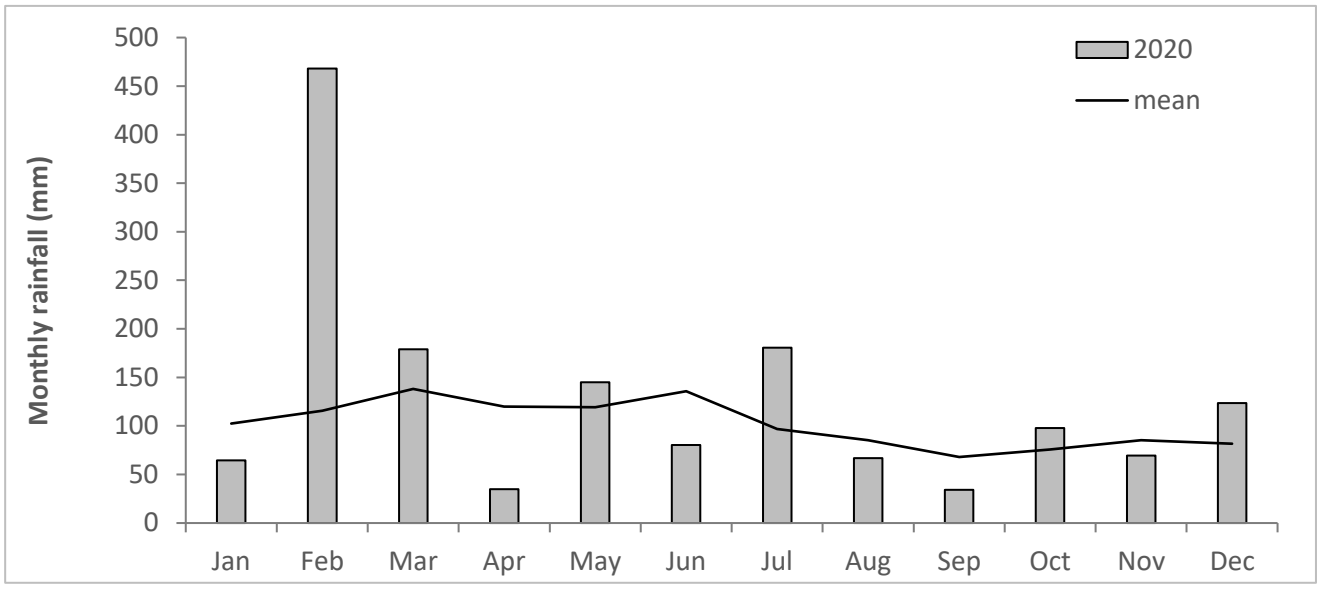

Figure 3. Monthly rainfall, Sydney: 2020 compared with mean values. Data for Sydney Botanical Gardens (station number: 066006; Bureau of Meteorology, Climate Data Online).

Recent fire history

Fire is a major driver of the structure and composition of Australian ecosystems, and hence wildlife habitat. Fire is an essential regenerative tool for the Eastern Suburbs Banksia Scrub (ESBS) and a fire interval of between 8 to 15 years is required to promote optimal regeneration and species richness for the dominant plant species within this community. Prior to 2020, control burns were last conducted on part of the headland in 2018.

In October 2020, a National Parks and Wildlife Service prescribed burn was conducted along an 8 ha perimeter of the sewerage treatment plant. The fire escaped containment lines and burnt a large proportion of the vegetation on the headland. A considerable proportion of the headland was burnt and much of the canopy was scorched due to the high intensity of the burn (see Results section). Only a small portion of 2020 burn areas experienced a cooler, understorey burn. The fire consumed much of the Bush Rat, Eastern Pygmy-possum and Brown Antechinus reintroduction area and adjacent ESBS, including areas where a range of species were well established and had been captured at high rates. In response to the fire, AWC developed a range of post fire-management strategies designed to maximise survival of persisting wildlife in both the short and long-term.

Methods

Ecohealth indicators and metrics

North Head's Ecohealth Monitoring Program has been designed to measure and report on the status and trends of species, ecological processes and threats on the sanctuary. The program focuses on selected biodiversity and threat indicators, using metrics derived from data collected through a series of purpose-designed surveys. A selection of species or guilds were chosen as biodiversity indicators which fit into one or more of the following categories: (1) declining and/or threatened species or guilds, (2) strong drivers of ecosystem function, or (3) are a member of the full range of taxa (to enable ongoing surveillance monitoring of a range of taxonomic groups to provide early warning of any unexpected declines).

On North Head, 20 biodiversity (species and guilds) indicators have been selected for monitoring (Table 1). Nine of these indicators were reported on in 2020. Threat metrics are selected to ensure monitoring the status and trends of introduced weeds, predators and herbivores and inappropriate fire regimes (where relevant). Six threat indicators have been selected for monitoring (Table 2). In 2020, 5 of these threat metrics were reported on. In future years, reporting for key weed species will be added.

Table 1. Biodiversity indicators for the Ecohealth Monitoring Plan for North Head. Rationale for selection: R = Reintroduced species; T = threatened or declining; D = strong driver of ecosystem function; S = surveillance monitoring. Metric definitions: Population estimate = number of individuals in project area; occupancy = proportion of sites recorded; richness = mean number of species per site; total richness = total number of species within guild across all sites.

Indicator					**Survey Method**	**Metric/s**
	T	D	S	R		
Mammals						
Reintroduced mammals						
Bush Rat (*Rattus fuscipes*)		*		*	Standard Trapping Survey	Abundance, occupancy
Eastern Pygmy-possum (*Cercartetus nanus*)	*	*		*	Pygmy Possum Nest Box Survey	Occupancy
Brown Antechinus (*Antechinus stuartii*)		*		*	Standard Trapping Survey	Occupancy
Extant small-medium mammals						
Short-beaked Echidna (*Tachyglossus aculeatus*)			*		Feral Predator Camera Survey	Occupancy
Long-nosed Bandicoot (*Perameles nasuta*)	*	*			Bandicoot Cage Trap Survey	Population estimate
Common Brushtail Possum (*Trichosurus vulpecula*)			*		Standard Trapping Survey	Abundance, occupancy
Common Ringtail Possum (*Pseudocheirus peregrinus*)			*		Nocturnal Spotlighting Survey	Abundance, occupancy
Bats						
Bat guild			*		Bat Survey	Occupancy, richness
Reptiles						
Small-medium reptiles			*		Standard Trapping Survey, Reptile Camera Survey	Occupancy, total richness
Birds						
Diurnal bird guild			*		Standard Bird Survey	Total richness, richness
Powerful Owl (*Ninox strenua*)	*				Nocturnal Spotlighting Survey	Presence/absence
Nocturnal bird guild			*		Nocturnal Spotlighting Survey	Occupancy, total richness

Indicator					Survey Method	Metric/s
	T	D	S	R		
Frogs						
Amphibian guild			*		Standard Frog Survey	Total richness
Red-Crowned Toadlet (*Pseudophryne australis*)	*				Targeted Toadlet Survey	Occupancy
Vegetation						
Threatened						
Eastern Suburbs Banksia Scrub	*				Banksia Scrub Mapping	Percentage senescent, percentage long unburnt
Eucalyptus camfieldii	*				TBD	Survey not yet conducted
Community						
Plant species		*	*		Vegetation Survey	Richness, total richness
Hollow bearing trees					Vegetation Survey	Mean number of trees with hollows per plot
Canopy cover		*	*		Vegetation Survey	Average percent canopy cover per plot
Ecological processes						
Pollination		*			Inflorescence Seed Set Count	Proportion of successful seed set

Table 2. Threat indicators for the Ecohealth Monitoring Plan for North Head. Metric definitions: activity = number of records/survey; occupancy = proportion of sites recorded.

Indicator	Rationale	Survey method	Metric/s
Feral predators			
Fox (*Vulpes vulpes*)	Major threat to wildlife	Feral Predators Camera Survey	Activity
Cat (*Felis catus*)	Major threat to wildlife	Feral Predators Camera Survey	Activity
Other			
Black rats (*Rattus rattus*)	Major threat to wildlife	Standard Trapping Survey	Abundance, occupancy
Vehicle strikes	Major threat to wildlife	Vehicle Strike Incidence Reports	Individuals killed
Fire			
Inappropriate fire regime	ESBS is optimally burnt every 8-15 years	Fire Scar Analysis	Area burnt by prescribed fire (ha) Area burnt by wildfire (ha)
Weeds			
Invasive weeds: - Lantana (*Lantana camara*), - Asparagus spp., - Bitou bush (*Chrysanthemoides monilifera subsp. rotundata*) - Boneseed (*Chrysanthemoides monilifera subsp. monilifera*) - Pampas grass (*Cortaderia spp.*)	Major threat to vegetation community	NPWS/SHFT monitoring	Area x Density (low, medium, high)

Survey types and history

To report on the Biodiversity and Threat Indicators, AWC survey teams conduct a variety of surveys repeated on a schedule varying in frequency from annually to once every 2-3 years. These include:

- Standard Trapping Survey
- Nocturnal Spotlighting Survey
- Pygmy Possum Nest Box Survey
- Bat Survey
- Reptile Camera Survey
- Standard Bird Survey
- Standard Frog Survey
- Targeted Toadlet Survey
- Vegetation Survey
- Inflorescence Seed Set Count
- Feral Predators Camera Survey
- Vehicle Strike Incident Reporting

In addition to ground-based ecological surveys, on-ground mapping data are analysed to compile the:

- Banksia Scrub Mapping
- Fire Scar Analysis

In addition, NSW National Parks and Wildlife Service and the SHFT conduct:

- Weed Surveys
- Feral Herbivores Surveys

In 2020, 7 surveys (Table 3) were conducted and these are presented in this report and the associated scorecard. In the scorecard, results from previous years' surveys are presented for indicators that were not surveyed in 2020.

Table 3. Survey effort for Ecohealth surveys on North Head Sanctuary in 2020

Survey name	Effort	Description/comment	Previous surveys
Standard Trapping Survey	1,200 live trap nights 760 camera trap nights	Elliott and cage trap nights (small mammals only: from a total possible 1,200: 20 sites, three nights, 10 traps/site, two surveys) Small mammals only (Brown Antechinus): 760 trap nights. 20 sites, 14 nights for survey one and 24 nights for survey two	2018, 2019 – 20 sites
Bandicoot Cage Trap Survey - Biennial	1, 470 trap nights	49 transects; 5 nights; 6 traps/site; one survey	2018 – 49 sites 2006, 8, 10, 12, 14, 16 – 47 sites
Pygmy Possum Nest Box Survey	378 surveys	63 nest boxes, six surveys	2019 – 63 sites
Standard Frog Survey	3 trap nights	3 trap sites, one night	2018 – 3 sites (x 2 surveys; n = 6)
Feral Predator Camera Survey	576 camera trap nights	Feral predator monitoring: 576 nights: eight sites, one camera/site, four surveys per year. Deployed for 14 nights for surveys 1 – 3, and for 30 nights for survey four.	2019 – 8 sites 2018 – 8 sites
Vehicle Strike Incident Reporting	Ongoing	Incident reporting process includes a mortality register maintained by AWC and NPWS.	Incident reporting commenced in 2017

Survey design and methods

Standard Trapping Survey

The Standard Trapping Survey is conducted at 20 survey sites across North Head, stratified by vegetation type (each broad vegetation type has a minimum of two survey sites; Figure 4). The survey entails live trapping and camera trapping small-medium mammals (Bush Rat, Brushtail Possum, Brown Antechinus, and introduced black rat, *Rattus rattus*). Surveys are conducted biannually.

The live trapping component of the Standard Trapping Survey, targeting Bush Rats, Brushtail Possums and introduced black rats, was conducted over three consecutive nights. Trapping sites comprise: 10 traps (5 x Elliott traps, 5 x cage traps) placed in pairs along a 100-m transect (~25 m intervals), with traps forming a pair being at least 10 m apart. Traps were lined with insulating material (e.g., leaf litter, coconut fibre) and baited with a mixture of peanut butter, oats and honey. Transects were separated by a distance of at least 100 m.

Concurrently, motion sensitive camera traps were deployed at each of the 20 sites to detect Brown Antechinus. A vertical, baited, camera trap was positioned in the centre of each site transect (i.e., at the 50 m point) and left in-situ for 14 nights. Cameras were positioned ~50 - 150 cm above ground in a tree. Universal bait placed in a tea strainer was attached to a tree in view of the camera. Camera settings were programmed as: Video on; Video duration: 15s; Quiet period: 1 min. In 2020, due to the October bushfire, the second round was extended for 12 days, amounting to 24 nights.

The Standard Trapping Survey was conducted in May and December 2020.

Bandicoot Cage Trap Survey

To survey the Long-nosed Bandicoot, AWC worked with NPWS to conduct live-trapping on 49 transects across North Head (Figure 5). Each site was stratified by vegetation type and comprised of a ~180 m transect. Six wire cage traps were placed along each transect, spaced 20 m apart. Each cage was baited with universal bait (oats, peanut butter and honey), replenished daily.

Pygmy Possum Nest Box Survey

Across North Head, 63 nest boxes (Figure 6) have been installed for monitoring small mammals (primarily reintroduced species: Eastern Pygmy-possum) on an annual basis. Nest box sites are stratified by vegetation type, with each broad vegetation type having a minimum of two nest boxes. Two consecutive rounds of nest box surveys were conducted over a 14-day period that coincided with each of the small mammal live trapping surveys in May and December. Two additional rounds were conducted outside of these. An additional 38 nest boxes were deployed in 2020 as a post-fire management response; formal surveys of these boxes will start in 2021.

Standard Frog Survey

Targeted Frog Surveys were undertaken at three ephemeral wetland sites: Hanging Swamp, Quarry, and Frog Pond (Figure 4). Surveys occurred following rain events and took place on warm nights in December. The Standard Frog Survey is conducted every two years.

Frogs were surveyed using a combination of targeted listening, call-playback and spotlight surveys within ephemeral wetlands. Surveys followed large rain events and took place on warm, wet nights in December. Due to COVID-19 restrictions one of the targeted survey periods (March) was not able to be surveyed, thus Amphibians were only surveyed once (December) instead of twice in 2020. At each wetland one observer listened for frog calls for a five-minute period. Then, calls for the Red-Crowned Toadlet were broadcast for one minute with responses recorded on the datasheet. Active searches were then conducted by spotlight for a 10-minute period. Searches were conducted along the margins of waterbodies.

Feral Predator Camera Survey

To monitor feral predators (foxes and cats), one unbaited camera was deployed at eight separate locations concurrently across North Head. Cameras were placed on the road/track network to target areas known to be frequented by foxes/cats. Surveys were undertaken four times each year. As North Head has no permanent fox/cat populations, monitoring feral predator presence is essential to allow a swift management response. The camera traps deployed to detect feral predator incursions were also used to detect Short-beaked Echidnas.

Cameras were attached to a tree using a python lock, situated horizontal and ~50 cm above ground and left in-situ for 14 days. Reconyx camera settings for photo images were as follows: Sensitivity: High; Number Images: 3 pics per trigger; Time between Triggers: Rapidfire, no lag between triggers. In 2020, due to the October bushfire, the fourth round of predator cameras was deployed for an additional 16 days, amounting to 30 days.

Vehicle Strike Incident Reporting

Throughout the year, when animals found to be injured or deceased across North Head by any stakeholder, including members of the public, are reported to SHFT Rangers or AWC Ecologists an incident report process is initiated. AWC completes a SHFT Incident Report Form, detailing location, cause of death (e.g. vehicle collision) and photos, where possible. Data from this incident reporting pertaining to Long-nosed Bandicoots is input into a Mortality Register maintained by AWC and NPWS. This Mortality Register is the source of data for the vehicle strike Ecohealth Metric.

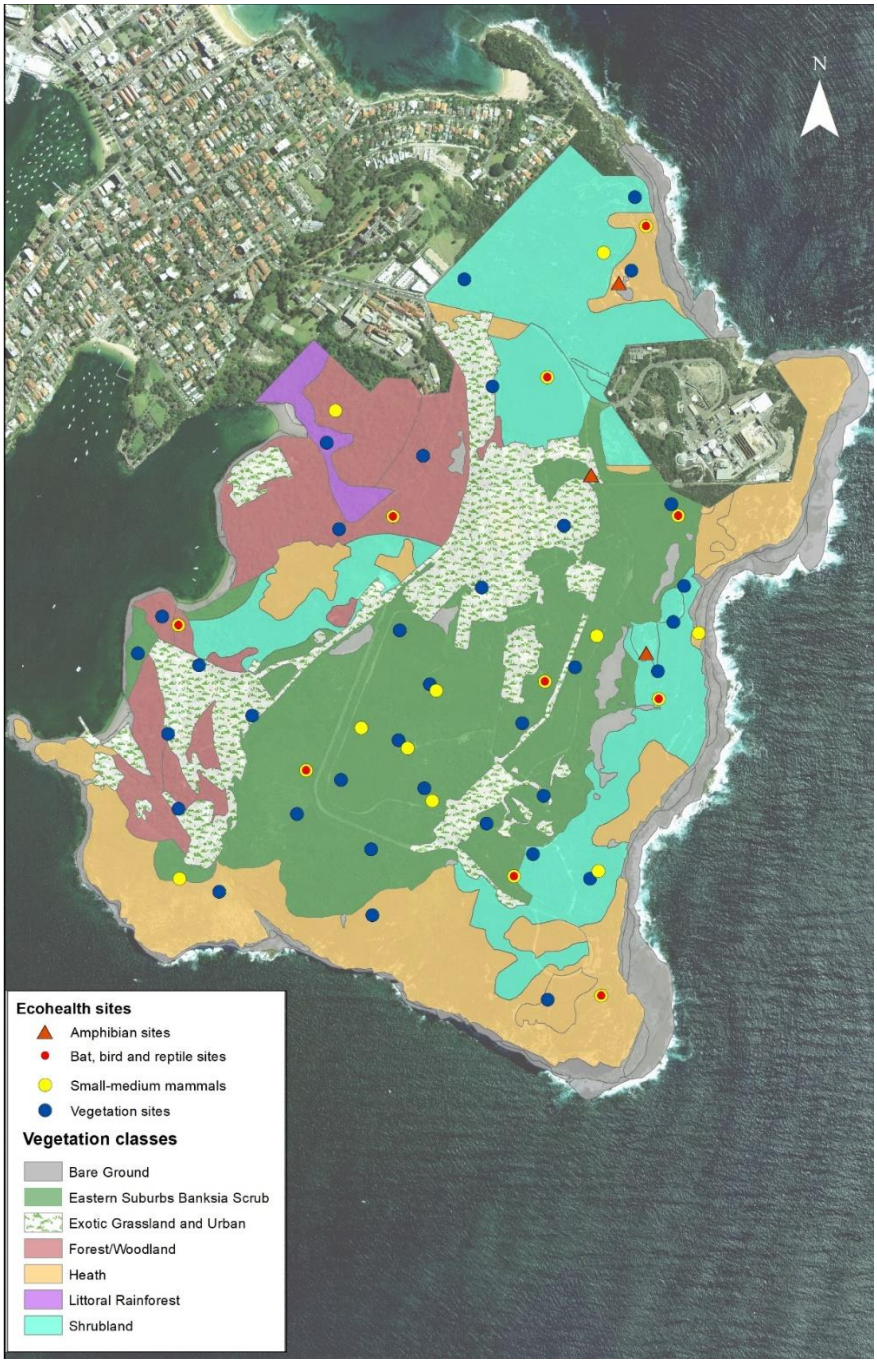

Figure 4. Location of all Ecohealth survey sites at North Head. Surveys include 35 vegetation sites (Vegetation Survey), 20 small-medium mammal sites (Standard Trapping Survey), 10 sites where birds, bats, arboreal mammals and reptiles are monitored (Standard Bird Survey, Reptile Camera Survey – not conducted in 2020) and 3 amphibian sites.

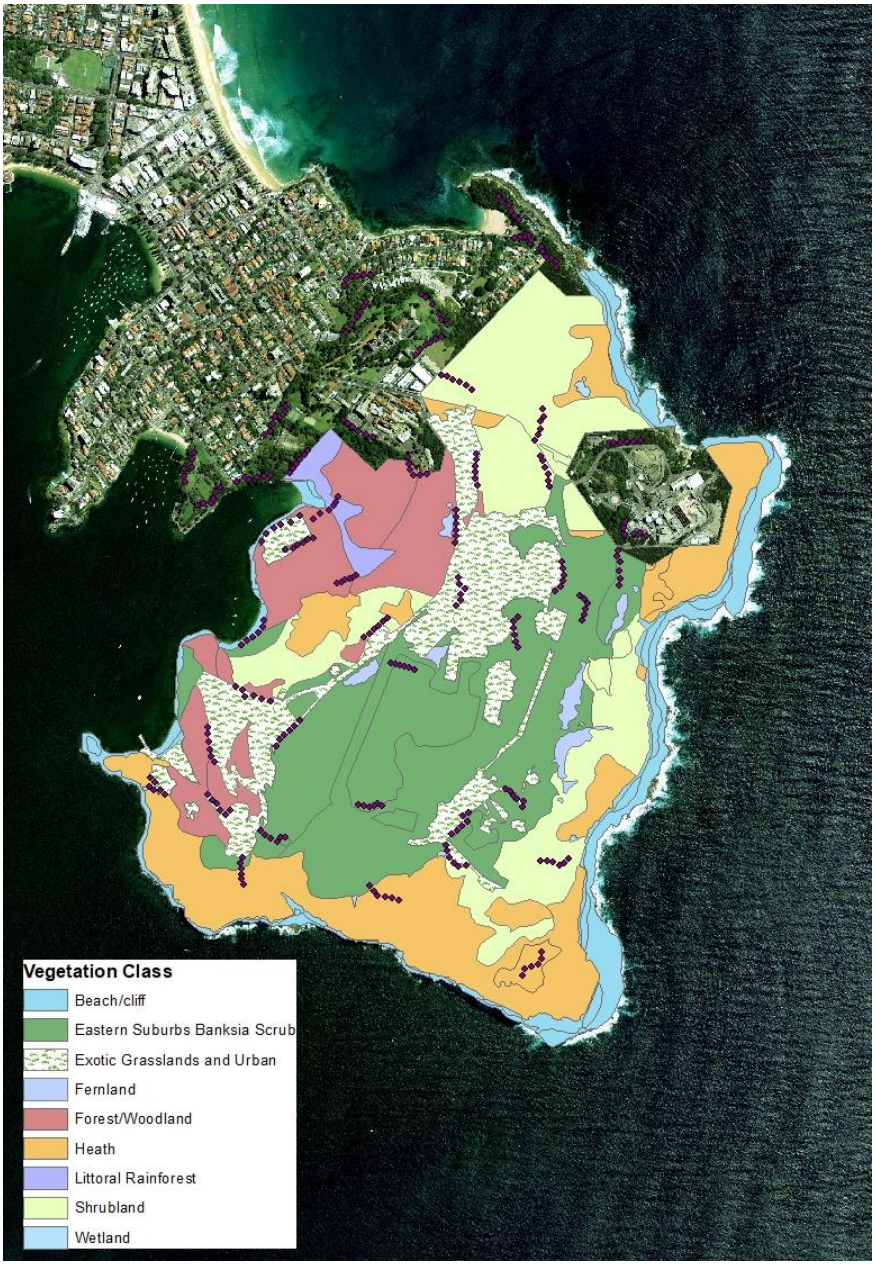

Figure 5. Map showing the location of the Long-nosed Bandicoot transects. 49 transects are deployed across the headland during the May biennial survey conducted by both AWC and NPWS, as the survey extends across SHFT and NPWS tenures.

Figure 6. Location of all nest boxes on North Head

Analysis methods

Biodiversity indicators

Bush Rats and Brushtail Possums

Abundance (i.e., total number of individuals, excluding recaptures/total trap nights * 100) and occupancy (proportion of sites occupied) were calculated for Bush Rats and Brushtail Possums. Data were obtained through Standard Trapping Survey at 20 sites where animals were uniquely marked to identify individuals.

Eastern Pygmy Possums

Nest box surveys for Eastern Pygmy-possum provide data on total captures (total number of individuals, excluding recaptures) and occupancy (proportion of nest boxes with records). Data were obtained through nest box checks (n=63) where animals were uniquely marked to identify individuals.

Brown Antechinus and Short-beaked Echidna

Camera traps deployed across the headland provided measures for Brown Antechinus (Standard Trapping Survey) and Short-beaked Echidna (Feral Predator Camera Survey). Cameras deployed at Standard Trapping Survey sites (n=20) were used to calculate occupancy (proportion of sites recorded) for Brown Antechinus, while cameras deployed at eight feral predator monitoring sites were used to calculate occupancy for Echidna. These metrics are useful where populations are too sparse to derive robust population estimates using live trapping methods.

Long-nosed Bandicoot

Population estimate (total number of individuals) of Long-nosed Bandicoots was calculated from cage trapping at 49 sites. Individuals were uniquely marked allowing for the use of capture-recapture analysis methods. A population estimate was calculated by the University of Sydney using the closed population estimation program, CAPTURE (within MARK; Banks and Price 2018).

Amphibian Guild

Total richness (total number of species within guild across all sites) was calculated for the amphibian guild.

Banksia Scrub Mapping

In many Australian ecosystems, recurrent fire is essential to maintain the structure and composition of plant communities and their dependent fauna, yet large areas of North Head had not been burnt for more than 30 years, until the escaped prescribed burn in October 2020. The long absence of fire is affecting the richness and diversity of plant communities on North Head. Additionally, research by AWC has shown that senescent ESBS does not provide high quality foraging habitat for Long-nosed Bandicoots. For the Eastern Suburbs Banksia Scrub Community, the percentage of total senescent ESBS and long unburnt was estimated from historical fire maps and remote sensing imagery.

Threat indicators

Feral predators

Cameras at eight sites provided data on activity (number of triggers per monitoring period) of foxes and cats. A 30-minute time interval was applied to all camera triggers to filter out multiple triggers from a single fox or cat.

Black rats

Trapping provided data on abundance (i.e., total number of individuals, excluding recaptures/total trap nights, * 100) and occupancy (proportion of sites occupied) of black rats across 20 sites.

Vehicle strike

Number, cause and location of recorded mortalities.

Fire Scar Mapping

Fire history was determined through fire mapping using remote sensing. Metrics were calculated for the extent of prescribed fire and wildfire across the entire headland. The extent of different vegetation types affected by fire was calculated, and fire intensity (qualitative assessment) was mapped. For ESBS, the area subject to Senescence (% of senescent 'Eastern Suburbs Banksia Scrub') was calculated, because of too long an interval between fires.

Results

Biodiversity indicators

Reintroduced mammals

Bush Rat

In 2020, the Bush Rat abundance estimate (i.e., total number of individuals captured per 100 trap nights, including unmarked animals and those captured in previous years) was 17/ 100 TN (Table 4). This metric has remained consistent since 2018. Bush Rats were detected at all 20 survey sites (Table 4). This metric has also remained stable since 2018, demonstrating the ongoing persistence of the Bush Rat population across the whole headland.

The escaped burn took place in October 2021. With biannual surveys conducted in May and November, the surveys fell on either side of the fire, providing metrics pre and post fire. Unexpectedly, the number of Bush Rats detected did not change over this period, with 98 (8.2/ 100 TN) Bush Rats captured in May and 104 (8.6 /100 TN) in November (Figure 11).

Table 4. Bush Rat abundance (number of individuals/ 100 TN) and occupancy (%) across survey sites

Species	Abundance			Occupancy (%)		
	2018	2019	2020	2018	2019	2020
Bush Rat	16.8	16.3	16.9	100	100	100

Eastern Pygmy-possum

In 2020, 17 individual Eastern Pygmy-possums (new captures only, excluding recaptures) were detected. This number is only slightly higher than that obtained in 2019 (n =15), but substantially more than the 2018 (n = 5). Eastern Pygmy-possum captures fluctuated throughout 2020. The second round of surveys in May and the single round of surveys in September saw the highest number of captures (n = 4). The first round of May and both December rounds experienced lower capture rates (n = 2). The decreased capture rates in both December rounds is likely due to the large-scale bushfire at North Head, which burnt 23% of the headland (Figure 8), including 46% of the Eastern Suburbs Banksia Scrub Community and 51% of the Heathland (Table 8), both of which are preferred habitat of the Eastern Pygmy-possum. Further monitoring in 2021 is required to identify the longer-term impact of the fire on the Eastern Pygmy-possum population.

In 2020, individual Eastern Pygmy Possums were captured in 13 out of 63 nest boxes (Figure 8), a total occupancy rate (combined across all rounds) of 24% (2 nest boxes giving rise to 3 captures across the year and 2 other nest boxes had more than 1 capture). Mean occupancy per survey was consistent between 2020 and 2019 (3.9%) but substantially higher than 2018 (1.3%; Figure 7) The total number of nest boxes occupied during each round remained constant with an average of 4% occupancy, although September had a noticeably higher occupancy rate of 6% (n = 4).

Following the October bushfire, 38 additional nest boxes were deployed across the headland which will be incorporated into nest box surveys from 2021.

Brown Antechinus

In 2020, camera trapping detected Brown Antechinus at 2 of 20 of sites. In 2019, Brown Antechinus were recorded at 3 sites, and in 2018 from 1 site. Sample size is too small to draw any meaningful conclusions about trends from these results. Ongoing population supplementation will likely be needed to ensure the establishment of Brown Antechinus at North Head.

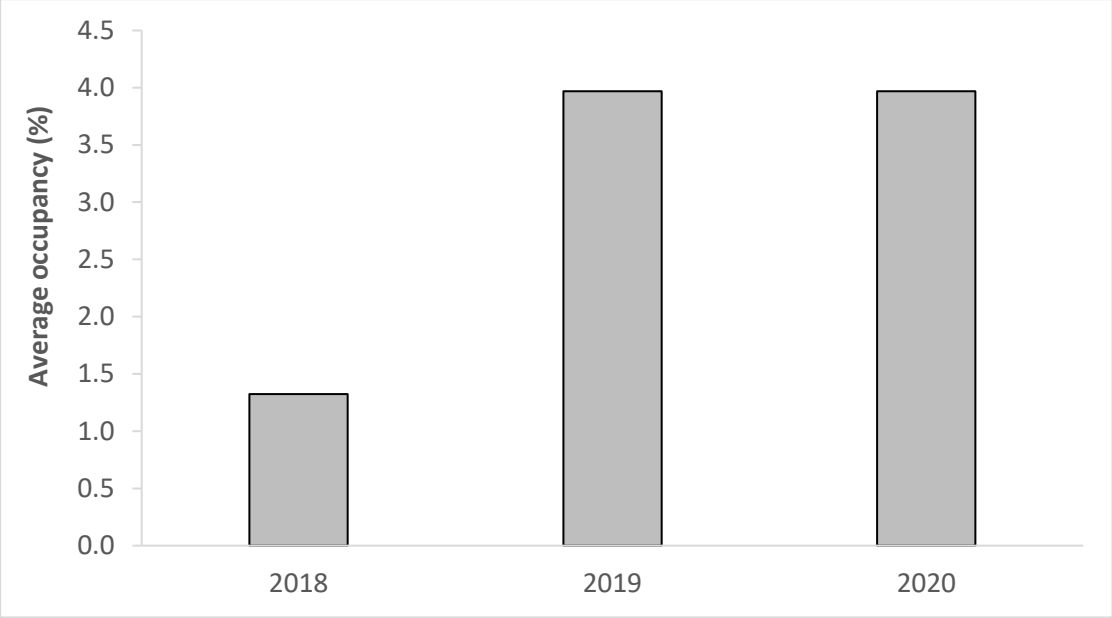

Figure 7. Eastern Pygmy-possum mean occupancy from nest box surveys throughout 2018 - 2020

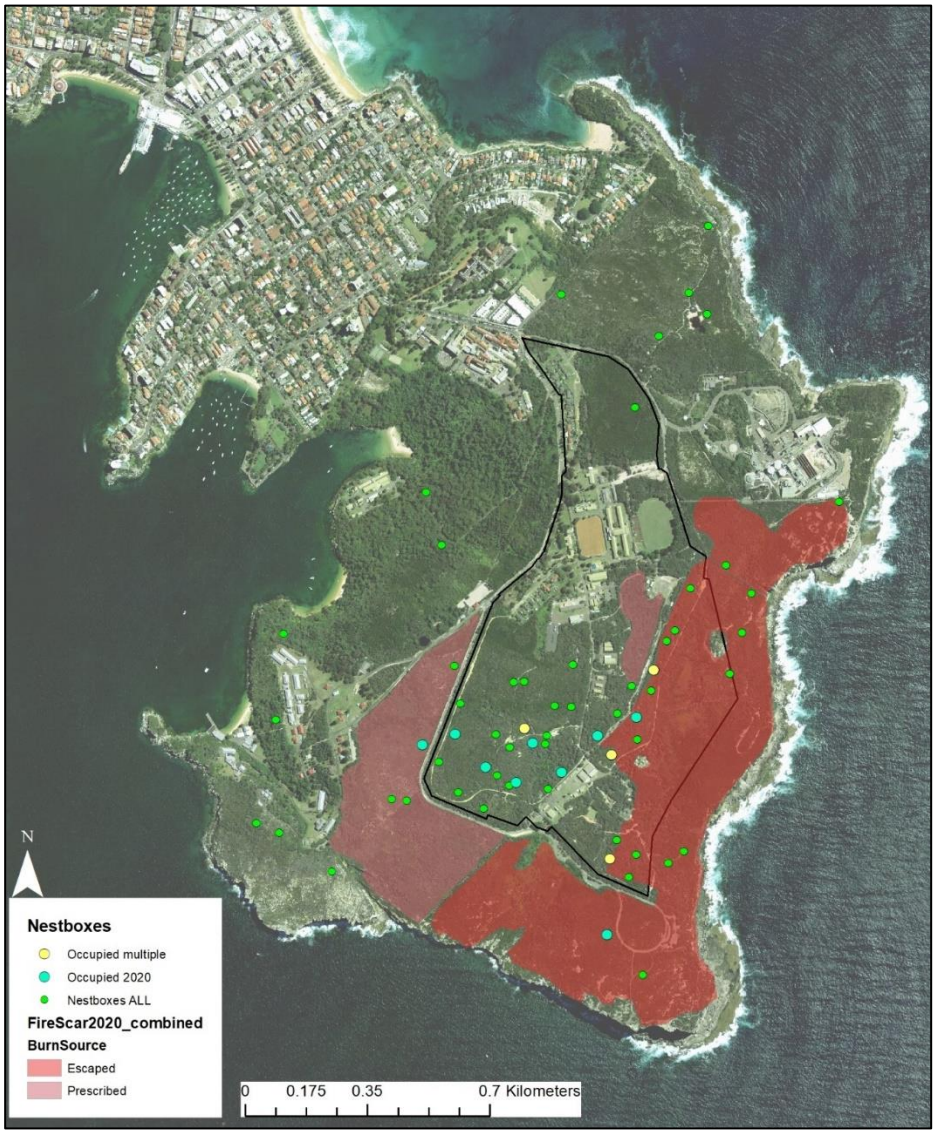

Figure 8. Locations of all nest boxes at North Head, including those occupied by Eastern Pygmy-possum in 2020 surveys. Blue = occupied nest boxes; yellow = nest boxes occupied multiple times; green = nest boxes not occupied in 2020, Red shading indicates the total area burnt in the escaped prescribed burn.

Extant small-medium mammals

Short-beaked Echidna

Camera trapping detected Echidnas at 4 of the 8 monitoring sites set up to detect predators in 2020. This is similar to results from previous years (2019 = 5/8 sites, 2018 = 4/8 sites).

Long-nosed Bandicoot

In 2020, 109 Long-nosed Bandicoots were trapped a total of 207 times across 49 transects over 5 nights. This is similar to the number of animals trapped in 2018 and 2016 and the fourth highest number of animals trapped since monitoring began (Figure 9). Results from population modelling (CAPTURE) estimate that the total population size at North Head is 183 individuals (Banks and Price, 2021). This is the highest estimate since monitoring began in 2004 and indicates a persistent upward trend in population size since 2010 (Figure 9).

These results indicate that the North Head population of Long-nosed Bandicoots is stable, however this survey was conducted before the large scale fire in October so results from the 2021 surveys will be essential in determining the impact of the 2020 bushfire on this endangered population.

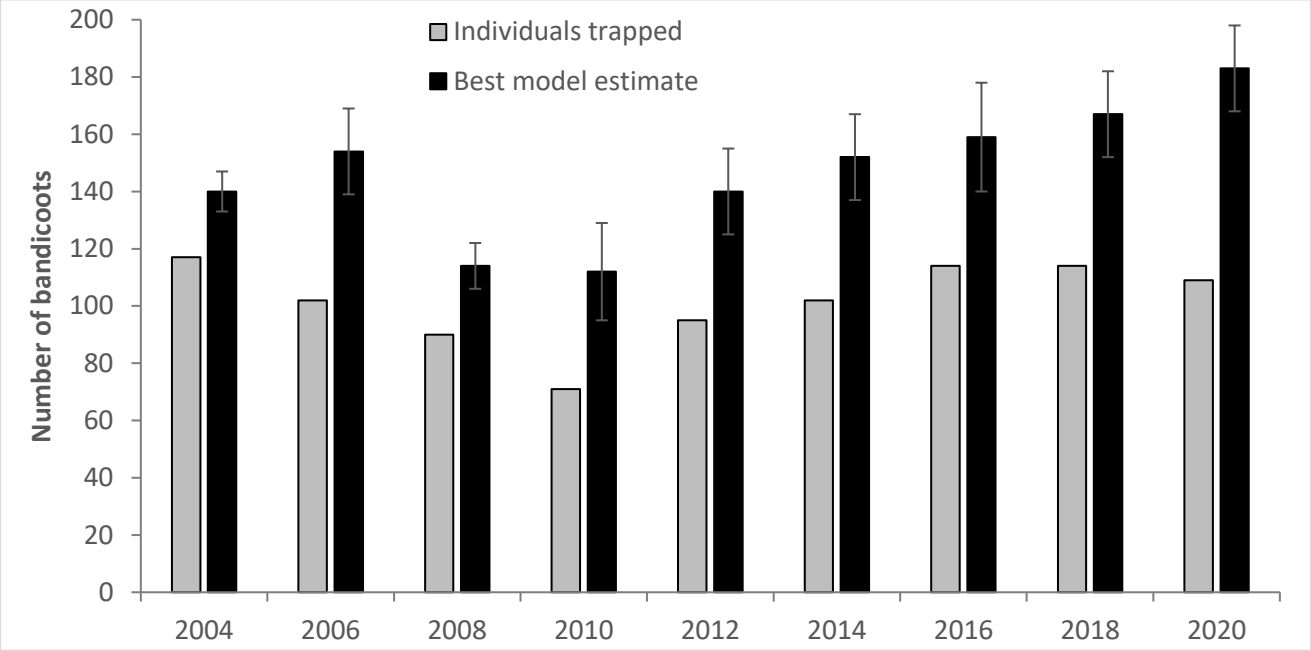

Figure 9. Comparison of the number of individual bandicoots trapped and the population estimate since surveys began in 2004. Population estimates are derived from mark recapture estimates in CAPTURE.

Common Brushtail Possum

The abundance for Common Brushtail Possums was 8.2/ 100 TN (Table 5). This is an increase compared with both 2018 and 2019. In 2020, more individuals were captured in the November survey (n = 32) than the May survey (n = 17). This may relate to animals being hungry in the post-fire environment in November 2020. Occupancy of Common Brushtail Possums across all trapping sites (n = 20) has seen a steady increase over the past few years. Since 2018, occupancy has increased by 5% each year to 85% in 2020. Increased occupancy, combined with the increase in the abundance estimate, likely reflects growth in the population size of Common Brushtail Possums on the headland. As the population grows, animals may be moving into parts of the headland not previously occupied.

Table 5. Brushtail Possum abundance (number of individuals/ 100 TN) and occupancy (%) across survey sites

Species	Abundance			Occupancy (%)		
	2018	2019	2020	2018	2019	2020
Common Brushtail Possum	6.3	5.0	8.2	70	75	85

Amphibians

Five species of amphibians (total richness = 5) were identified during the 2020 surveys at North Head; Common Eastern Froglet (*Crinia signifera*), Striped Marsh Frog (*Limnodynastes peronii*), Eastern Dwarf Tree Frog (*Litoria fallax*), Freycinet's Frog (*Litoria freycineti*) and Peron's Tree Frog (*Litoria peronii*). This is two fewer species than detected in 2018 surveys, when the Spotted Grass Frog (*Limnodynastes tasmaniensis*) and threatened Red-Crowned Toadlet were recorded. However, survey effort was lower in 2020 (sites surveyed once) than 2018 (sites surveyed twice), which may influence these results.

Of the 3 survey sites, the Quarry has the highest richness. This highlights the importance of maintaining this habitat, as it is the only body of water that is consistently full on North Head, even in drought.

The threatened Red-Crowned Toadlet was not identified in 2020 surveys, despite being recorded at 33% of sites in 2018. This may be due to prior detection occurring during the early autumn survey, which was not conducted in 2020. However, the 2020 survey was conducted after the wildfire burnt across part of North Head. Frogs may have been negatively affected by this event (e.g., due to reduced water availability and/or water toxicity: Dahm et al. 2015).

Banksia Scrub Mapping

During 2020, nearly 50% of all ESBS on North Head was burnt. Although this reduction in available habitat is likely detrimental to the fauna on the headland in the short- to medium-term, in the longer term, the increased extend of fire may be positive for the health of the ESBS, given that much of the ecosystem had been long-unburnt and become senescent. Since 2019 there has been a reduction in the proportion of ESBS classified as senescent (from 70% to 21%) and long unburnt (from 79% to 47%) (Table 6).

Table 6. Proportion of Eastern Suburbs Banksia Scrub Community at North Head that is senescent and long unburnt. Estimates are obtained from ArcMap vegetation layers and fire scar boundaries.

Year	Percentage of senescent ESBS (%)	Percentage long unburnt ESBS (%)
2019	70	79
2020	21	47

Threats

Feral predators

Feral predator monitoring surveys conducted in 2020 detected fox activity, but no cat activity. Cat incursions have seen a decreasing trend which can be seen through decreasing number of triggers between 2016 and 2020 (Figure 10). There have been no cats captured on predator cameras since 2018. This may be due to an increased effort from AWC and NPWS in educating the public on the importance of keeping cats inside and the enforcement of a zero-pet policy on the headland.

In 2020, 2 of the 4 surveys detected fox activity, with multiple trigger events in June and one in September. In May 2020, there was a known incursion of a fox on the headland (sightings); for this reason, predator cameras were immediately deployed, and the subsequent camera triggers led to the capture and removal of a fox from the headland. No further triggers were detected following the removal of the fox. Although multiple trigger events were detected, this does not necessarily represent multiple fox incursions. A single animal can result in multiple detections as it moves around the headland in search of prey.

The low level of fox activity on the headland is likely due to a range of incursion preventative measures, including camera monitoring, baiting, trapping, and cohesive management and monitoring by AWC and SHFT in partnership with NPWS.

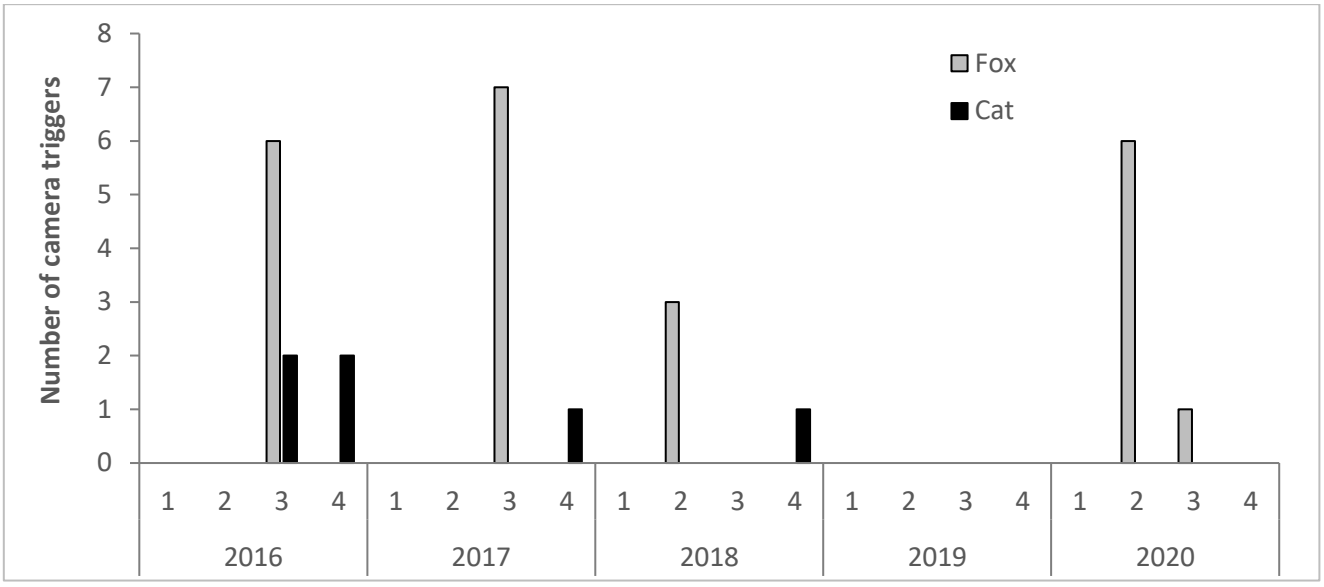

Figure 10. Number of feral predator (fox and cat) camera triggers from 2016-2020. Data are shown for each survey round (n=4) each year. Survey rounds are carried out in the same time each year; 1 = March/April, 2 = June/July, 3 = September/October and 4 = December.

Black rats

Black rats are an invasive rodent species and are highly successful colonisers. Black rats act as a vector for a range of diseases and ectoparasites. They can also negatively impact native fauna through both predation and competition (Banks and Hughes 2012). North Head has an established population of black rats that is likely to limit recruitment and access to resources for native fauna. An intensive removal program in parts of the headland has been undertaken with the program to establish a Bush Rat population at North Head.

In 2020, monitoring of black rats was conducted through biannual trapping surveys associated with monitoring the reintroduced small mammal and bandicoot populations. Black rats were captured at 50% of trapping sites, with an abundance estimate (i.e., total number of individuals captured per 100 trap nights) of 2.4/ 100 TN (Table 7). Both the abundance estimate and occupancy were substantially lower in 2020 than previous years.

Table 7. Black rat abundance (total individuals per 100 trap nights) and site occupancy between 2018-2020

Species	Abundance			Occupancy (%)		
	2020	2019	2018	2020	2019	2018
Black rat	2.4	9.3	8.2	50	100	90

The decline in black rat numbers is likely a consequence of previous black rat removal efforts (between 2014 – 2016) and the re-establishment of the native Bush Rat on the headland. Bush Rats accounted for 86% of all rodent captures in 2020, compared to 14% for the black rat (Figure 11). Following intensive reintroduction efforts, the native Bush Rat is now likely an established species and therefore has a competitive advantage over the black rat which is unable to infiltrate back into areas of prime habitat where the Bush Rat is now resident (Stokes et al. 2009).

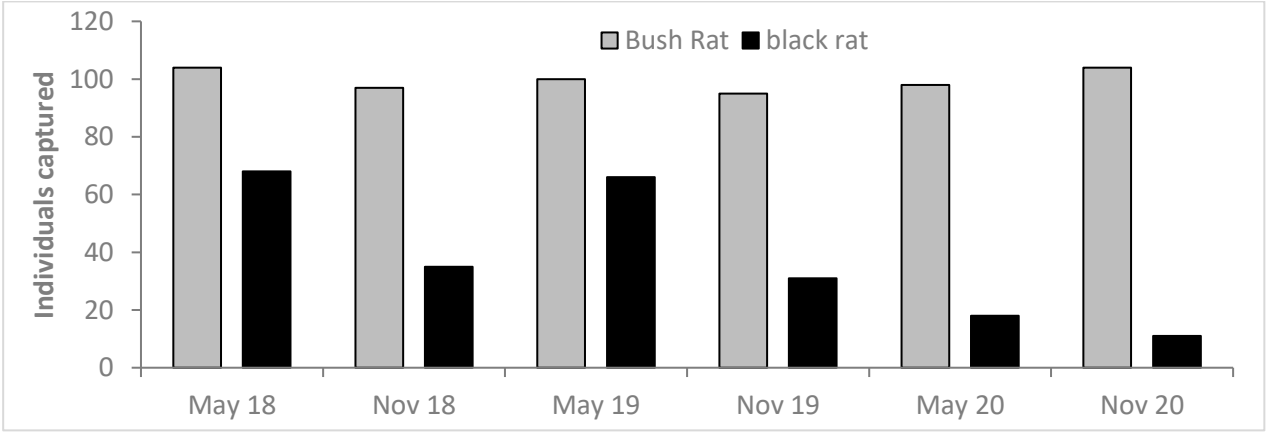

Figure 11. Capture rates of Bush Rats and black rats during May and November surveys from 2018-2020

Vehicle strikes

A total of 7 Long-nosed Bandicoot vehicle strike mortalities were reported and logged in 2020. Mortalities were reported from locations across both NPWS and SHFT tenure (i.e., across the entire headland). March saw the highest number of vehicle strike mortalities (n = 3) which may be due to a sudden increase in headland visitation and utilisation of green spaces during the start of COVID19. The remainder of mortalities (n = 4) occurred in April, August, November and December.

In previous years, vehicle strike mortalities have seen a decreasing trend (Figure 12) likely due to scheduled park closures and increased signage. In addition to increased greenspace use, the slight increase in 2020 compared to 2019 may be a result of additional traffic associated with the presence of a production crew on the headland.

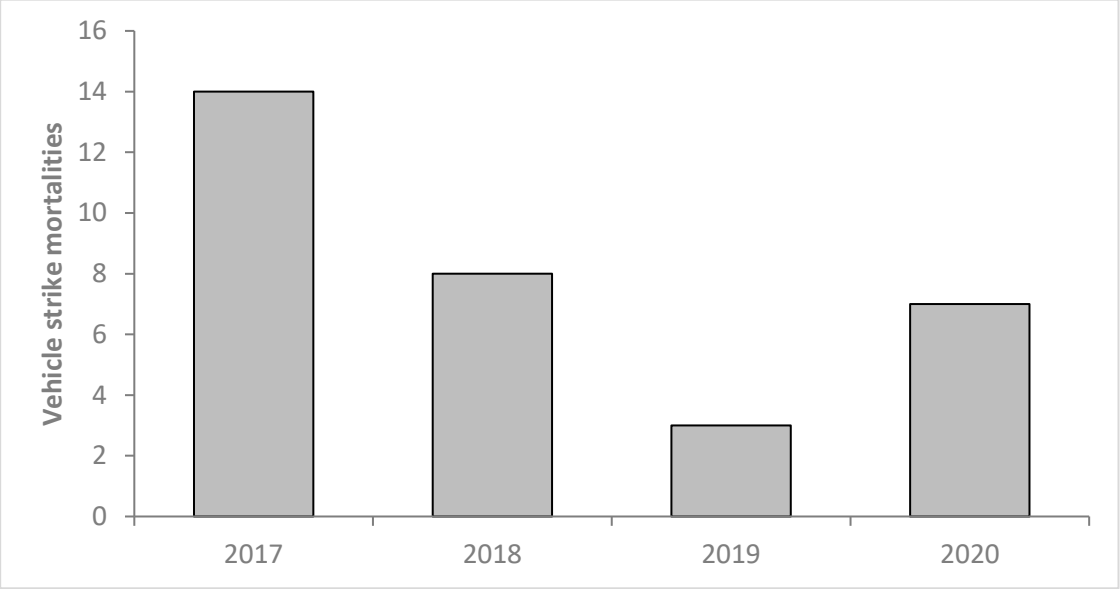

Figure 12. Long-nosed Bandicoot vehicle strike mortalities from 2017-2020

Fire

Approximately 56.9 ha of habitat was burnt in the escaped fire (Figure 13), 16 ha of which is managed for SHFT by AWC. Together with the 21.3 ha burnt in the September prescribed burns (2.1 ha of which is managed by AWC), 24% of SHFT land is currently recently burnt and 78.2 ha (37%) of North Head is currently in differing stages of post-fire recovery. During the October fire, much of the canopy was scorched due to the high intensity of the burn (Figure 14).

A range of vegetation types were consumed by both the escaped and prescribed burns, with almost 50% of the ESBS on the headland now extensively burnt (Table 8, Figure 13, and Figure 15). In addition to the area of ESBS, 87% of the fernland habitat was burned on the headland. This vegetation type is highly sensitive to disturbance and a preferred habitat of many of the ground dwelling mammals.

Table 8. Total area (ha) of vegetation types, including proportion burnt in September prescribed burns and October escaped burn (note: some areas not classified as vegetation (e.g., tracks) were also impacted by fire but are not shown here)

Vegetation types	Area (ha)	Area burnt (ha)	Area burnt (%)
Eastern Suburbs Banksia Scrub	68.7	31.3	46
Exotic Grassland and Urban	36	0.5	1
Fernland	3.1	2.7	87
Heath	51.9	26.7	51
Shrubland	50.4	16.2	32
Total	210.1	78.2	37

Figure 13. Map of North Head showing area of burnt habitat in September prescribed burns and October escaped burn

Figure 14. Map of North Head showing the total area of burnt habitat where only the understory was burnt vs the area where understory and canopy was burnt

Figure 15. Vegetation types burnt in September prescribed burns and October escaped burn

Discussion

Fire and associated impacts

North Head is an area of high biodiversity value in Sydney, being an 'island' of relatively intact natural vegetation surrounded by urbanisation. It contains the majority of the remaining Critically Endangered ESBS community and supports a vast array of native species. Fire is an important component of the ecology of the headland, with patchy, lower intensity burns working to maintain vegetation diversity in heathland and the ESBS community. In contrast, wide-scale high intensity burns can homogenise vegetation, damage vegetation types less adapted to fire, reduce habitat suitability and key resources for some species (potentially resulting in increased competition for resources), and increase risk of predation by both native and feral predators.

In October 2020, a prescribed fire escaped containment lines and burnt ~23% of the headland (including ~22% of the SHFT/AWC project area). Most of the fire scar was subjected to high intensity fire resulting in complete vegetation removal. This has dramatically altered vegetation structure across the headland and reduced the area of available habitat for species dependent on older vegetation successional stages. Mortality of wildlife directly related to the fire was observed, with many dead and severely injured animals found in the days following the escaped burn. Following the escaped burn, a number of native species showed signs of negative impacts with evidence of direct mortality and declining body health check indicators.

Post-fire recovery will be a slow process. It will likely take several years for vegetation to recover and attain structural complexity that resembles pre-fire conditions. Fauna species can be expected to be directly or indirectly impacted by the fire for several years. AWC has initiated a range of post-fire response activities aimed at supporting fauna populations and facilitating recolonisation of burnt areas (e.g., provision of supplementary food and water, deployment of artificial habitat/shelter in the fire scar). Monitoring in 2021 and beyond will be important for a better understanding of the full impacts of the burn.

Reintroduced mammals

Since their reintroduction, Bush Rats have become one of the most common native mammal species on the headland. Capture rates remained high in 2020 and Bush Rats continued to be detected at all survey sites. Importantly, establishment of a Bush Rat population at North Head now appears to be delaying/preventing the invasive black rat from becoming numerically dominant.

Eastern Pygmy-possums maintained their presence at North Head in 2020, but as for previous years, were detected in low numbers. Detection of this species may have been impacted by the escaped fire, with several previously occupied nest boxes located in the fire scar. Damaged nest boxes were replaced, and 38 additional boxes deployed, to facilitate monitoring of this species into the future.

The Brown Antechinus also remained difficult to detect, with records from just two of 20 survey sites in 2020. Since reintroduction this species has not been recorded at more than three survey sites in a given year.

Through the reintroduction of Bush Rats, Eastern Pygmy-possums and Brown Antechinus, AWC has increased the overall native mammal richness on the headland from five to eight species. Prior to this reintroduction program, no native mammals smaller than ~700 g persisted at North Head. Given low detection rates for both Eastern Pygmy-possum and Brown Antechinus, additional translocations will likely be required to supplement the existing populations and ensure the establishment of these species on the headland. Immediate plans to conduct this work have been postponed until a clearer understanding of the impact of the escaped fire on these species is obtained.

Long-nosed Bandicoot

The number of Long-nosed Bandicoots captured on the headland has remained relatively stable since 2016. Despite this, the population estimate has been gradually increasing with each survey since 2010. The population estimate is dependent on total recaptures; increasing estimates through time likely reflect higher numbers of 'new' animals towards the end of surveys. Despite the Long-nosed Bandicoot population being stable on the headland, total population size is still relatively small, making the population vulnerable to inbreeding and other stochastic processes. Ongoing monitoring and management is required. It should also be emphasised that the impact of the escaped fire on the Long-nosed Bandicoot population is not yet understood as 2020 surveys were conducted prior to the fire.

Feral predators

Feral cats and foxes are generally not resident on the headland, further enhancing the conservation value of North Head. However, incursions do occur occasionally. AWC deploys cameras to monitor for incursions and also collates records relating to incidental/opportunistic sightings. When an incursion is suspected, NPWS initiates a baiting/trapping program to remove the animal in question.

No cats were detected in 2020, continuing the trend from the previous year. Some fox activity was detected, triggering a targeted removal program by NPWS. Following the removal of a single animal, no further fox activity was recorded.

To ensure the ongoing persistence of native fauna at North Head, continued monitoring and removal of feral predators is required. This will be of even greater importance in the coming years as North Head recovers from the escaped fire. Keeping cats and foxes off the headland will enhance the ability of native fauna to recolonise burnt areas where they are otherwise more vulnerable to predation.

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AWC acknowledges the Gayamaygal people as the Traditional Custodians of the country on which North Head resides. We also acknowledge their continuing connection to land, culture and community. We pay our respects to Gayamaygal Elders past present and emerging.

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